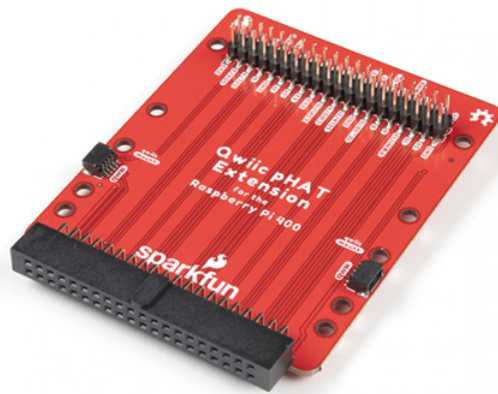


Qwiic pHAT Extension for Raspberry Pi 400 Hookup Guide

Introduction

The SparkFun Qwiic pHAT extension for the Raspberry Pi 400 is the quick and easy solution to access the GPIO, stack your favorite pHAT right-side up, or connect a Qwiic-enabled device to the I²C bus (GND, 3.3V, SDA, and SCL).



SparkFun Qwiic pHAT Extension for Raspberry Pi 400
© DEV-17512

Product Showcase: Qwiic pHAT Extension





Required Materials

To follow along with this tutorial, you will need the following materials. You may not need everything though depending on what you have. Add it to your cart, read through the guide, and adjust the cart as necessary.

Note: Below is a wishlist with the minimum parts to get started. You'll still a monitor/tv with HDMI input.

Qwiic pHAT Extension Wishlist SparkFun Wish List



Raspberry Pi 400 Personal Computer Kit
KIT-17377



SparkFun Qwiic pHAT Extension for Raspberry Pi 400
DEV-17512

Raspberry Pi 400

You'll need a Raspberry Pi 400s. There are two options available. One that is just the Raspberry Pi 400 sold individually. Another that is sold in a kit with everything but the monitor.



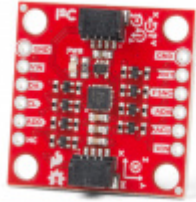
Raspberry Pi 400 Personal Computer (Unit Only)
○ DEV-17376



Raspberry Pi 400 Personal Computer Kit
○ KIT-17377

Qwiic-Enabled Device

Now you probably didn't buy the Qwiic pHAT extension if you didn't have any Qwiic products to use with it, right? If you don't have any Qwiic products, the following might not be a bad place to start since they have a Python drivers written for the devices.



SparkFun 9DoF IMU Breakout - ICM-20948 (Qwiic)

● SEN-15335



SparkFun Environmental Combo Breakout - CCS811/BME280 (Qwiic)

● SEN-14348



SparkFun GPS Breakout - XA1110 (Qwiic)

● GPS-14414



SparkFun Proximity Sensor Breakout - 20cm, VCNL4040 (Qwiic)

● SEN-15177

You'll need our handy Qwiic cables to easily connect sensors to your Qwiic pHAT. Below are a few options.



Qwiic Cable - 100mm

● PRT-14427



Qwiic Cable - 500mm

● PRT-14429



Qwiic Cable - 50mm

● PRT-14426



Qwiic Cable - 200mm

● PRT-14428

Required Setup Tools

As a desktop, these devices are required. If you received the Raspberry Pi 400 Kit, you'll just need a display and cable. Depending on your display, you may need an HDMI converter to connect to older monitors and TVs.

- USB Mouse
- HDMI monitor/TV with cable
 - *Optional: HDMI Converter*
- 5V Power Supply

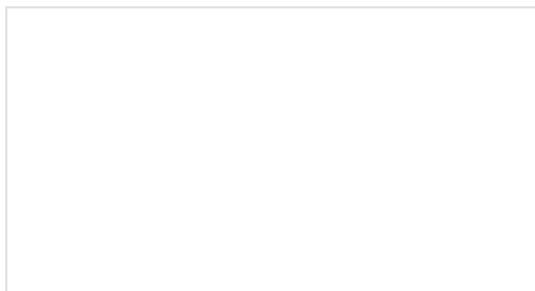
Suggested Reading

If you aren't familiar with the Qwiic system, we recommend reading here for an overview.



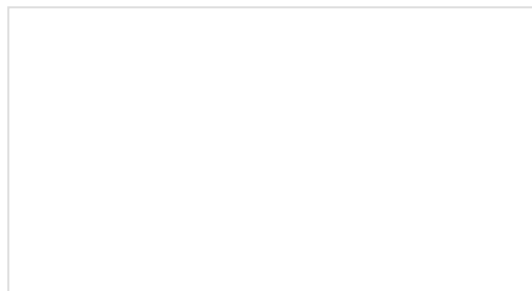
Qwiic Connect System

We would also recommend taking a look at the following tutorials if you aren't familiar with them.



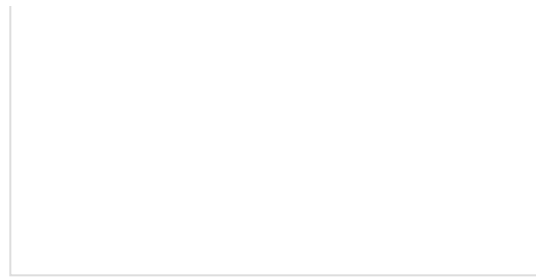
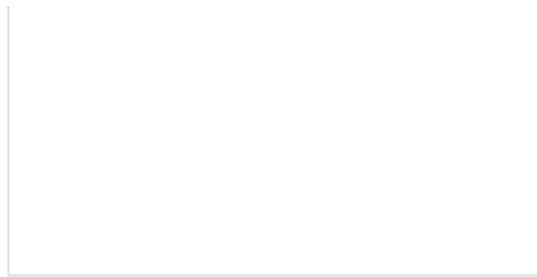
Serial Peripheral Interface (SPI)

SPI is commonly used to connect microcontrollers to peripherals such as sensors, shift registers, and SD cards.



I2C

An introduction to I2C, one of the main embedded communications protocols in use today.



Serial Terminal Basics

This tutorial will show you how to communicate with your serial devices using a variety of terminal emulator applications.

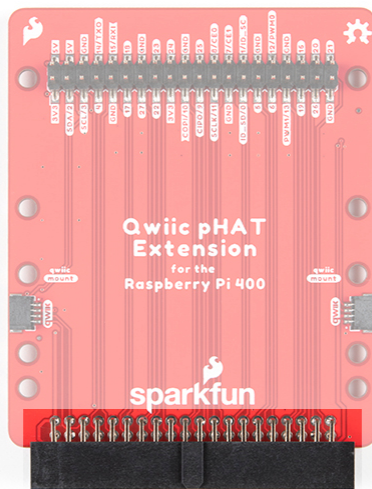
Raspberry gPlo

How to use either Python or C++ to drive the I/O lines on a Raspberry Pi.

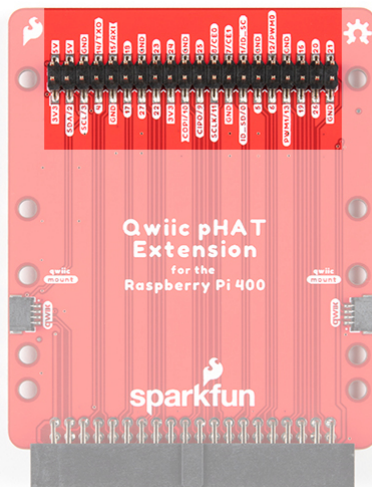
Hardware Overview

2x20 Raspberry Pi Header

The Qwiic pHAT extension connects to the Raspberry Pi 400's 2x20 port via the right angle header.

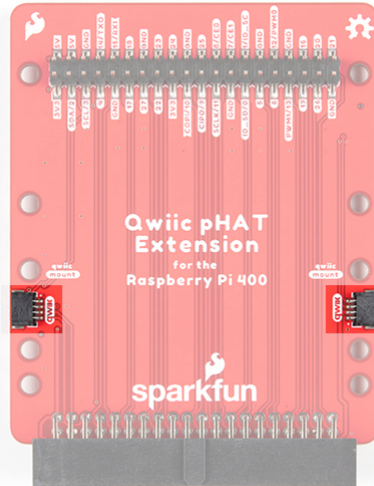


The Raspberry Pi 400's horizontal headers are rerouted and extends out to the vertical headers at the top of the board. Each pin includes a label with their associated pin function.



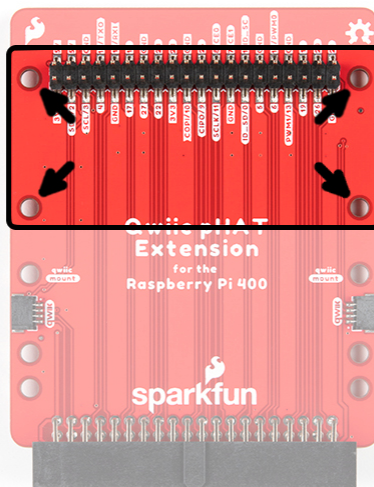
Qwiic Connectors

The Qwiic pHAT extension includes Qwiic connectors on both sides of the board.

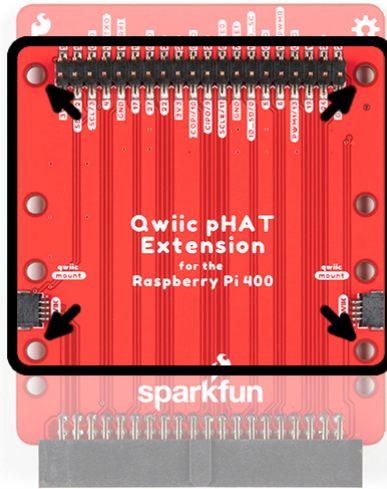


Mounting Holes

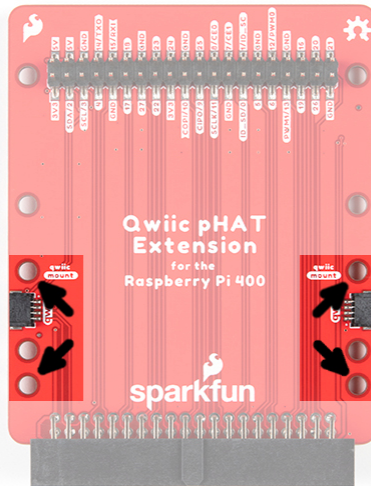
There are 10 mounting holes on the board. Below is the board highlighted for boards designed with the Pi Zero footprint. You can add standoffs to the mounting holes where the arrows are pointing.



For boards designed with the Raspberry Pi footprint, you can add standoffs to the mounting holes where the arrows are pointing.

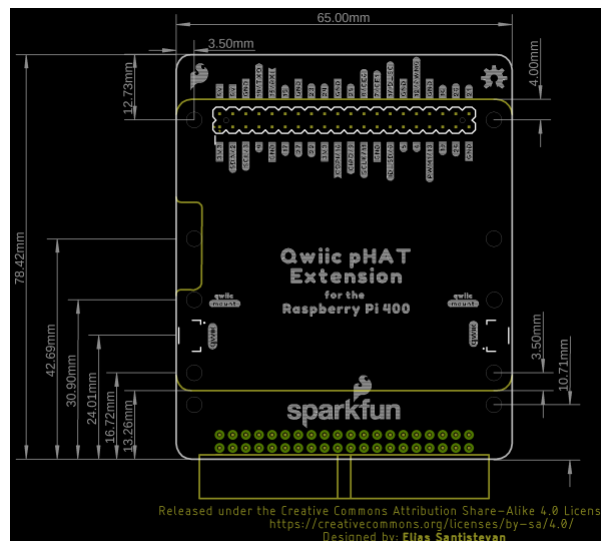


For Qwiic-enabled devices utilizing the standard 1.0"x1.0" sized boards, you can add two standoffs for each Qwiic-enabled device where the arrows are pointing.



Board Dimensions

The board is about 65mm x 78.42mm (~2.55in x ~3.08in).



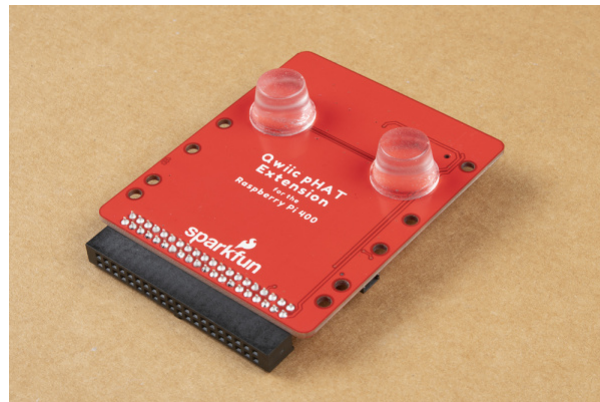
By adding two large silicone bumpers under the board for stability, the height comes to about ~21.32mm (~0.84in) between the header pin and the bottom of the Silicon bumper.

Hardware Assembly

Included with the Qwiic pHAT extension board is a set of large silicone bumpers. These are meant to hold the board up when it is attached to a Raspberry Pi 400 and placed on a table. You only need 2 out of the 4 silicone bumpers so you can use the left over bumpers for other projects.



To attach the two silicone bumpers, peel one bumper and attach it to the bottom of the board between the mounting holes of the Pi Zero's footprint. Repeat for the second bumper. Your setup should look similar to the image below.



Note: Due to the design of the Raspberry Pi 400, the Qwiic pHAT extension will be closer to the table as you move toward the right angle headers. Care must be taken when sticking the large silicone bumpers to the board as this may add additional stress to the connection between the Qwiic pHAT extension and the Pi 400. We recommend placing the silicone bumpers close to the vertical header pins to reduce the amount of stress applied on the connection.

At this point, we'll assume that you have flashed an image and inserted the microSD card into the Raspberry Pi 400. With the straight header pins facing up, slide the Qwiic pHAT extension into the Raspberry Pi 400's GPIO port. The right angle connector is keyed so there's only one way to insert the board into the GPIO port.



When removing the pHAT extension, simply wiggle the board slowly up and down as the board is being pulled away from the Raspberry Pi 400.

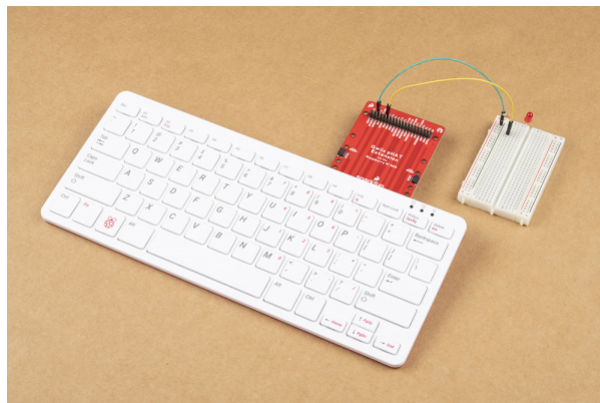
Qwiic-Enabled Devices

If you have a Qwiic-enabled device, simply insert a Qwiic cable of your choice between the Qwiic board and the Qwiic pHAT extension. While you can connect to either Qwiic connector, the right side of the Qwiic pHAT extension will provide more space since most of the Pi's peripherals will be inserted to the left of the board.



Breadboard Prototyping

Connecting to the Raspberry Pi 400's GPIO is easy with the pin functions printed on the board for reference. We recommend using M/F jumper wires to connect when prototyping your circuit on a breadboard.



Stacking pHATs

Boards designed with the Raspberry Pi or Pi Zero footprint can be stacked on top of the Qwiic pHAT Extension allowing it to be viewed right-side up. Below is an image of the Top pHAT connected to the Raspberry Pi 400.



Depending on the design of the pHAT, you may require additional height if there are any wires being attached to the bottom of the pHAT. If this is the case, you can add additional height using an extended GPIO headers.



Extended GPIO Female Header - 2x20 Pin
(16mm/7.30mm)

● PRT-16763

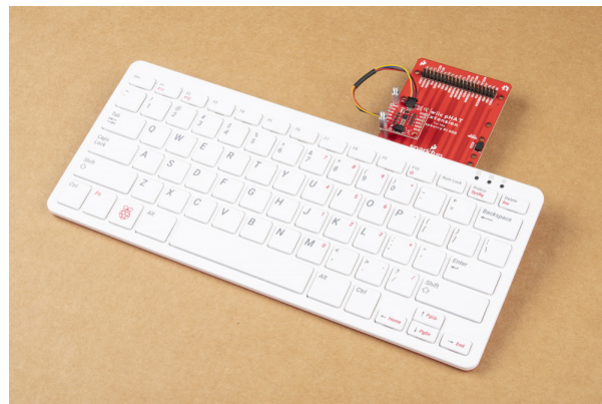


Extended GPIO Female Header - 2x20 Pin
(13.5mm/9.80mm)

● PRT-16764

Mounting with Standoffs

You can attach standoffs to two of the Qwiic mounting holes to secure an Qwiic-enabled device.

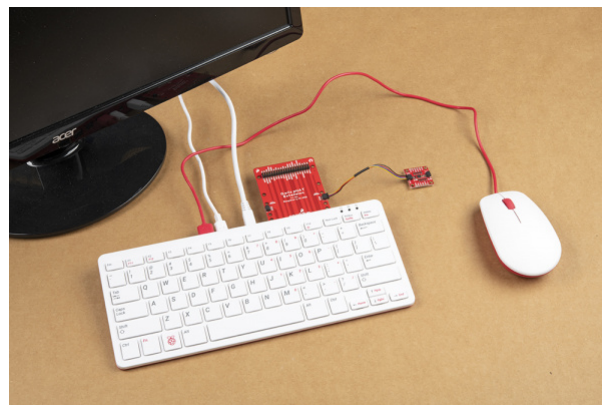


Got a wobbly pHAT on the Qwiic pHAT extension? You can attach standoffs to two of the mounting holes across from the vertical header pins on the Qwiic pHAT extension. Of course, you can always use all four mounting holes depending on your personal preference. Below is a Top pHAT using the Raspberry Pi's footprint but you can also mount a board that uses a Raspberry Pi Zero's footprint as well.



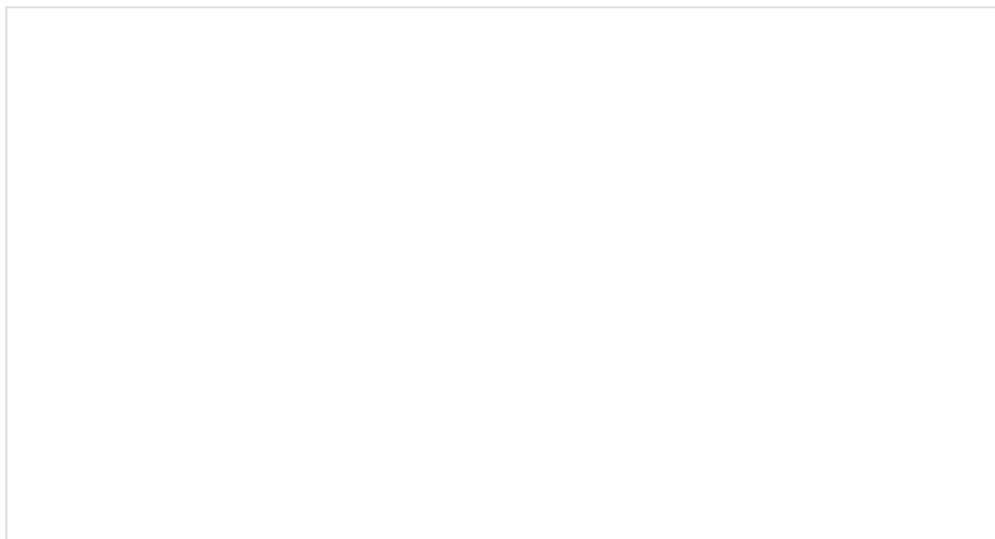
Raspberry Pi 400 Peripherals

If you have not already, connect your peripherals (e.g. display cable, mouse, power, etc) to the Raspberry Pi 400! Your setup will look similar to the image below.



Getting an OS

We recommend checking out the [Raspberry Pi 4 Hookup Guide](#) to install the operating system to flash the image to your microSD card for detailed instructions.



Raspberry Pi 4 Kit Hookup Guide

MARCH 14, 2020

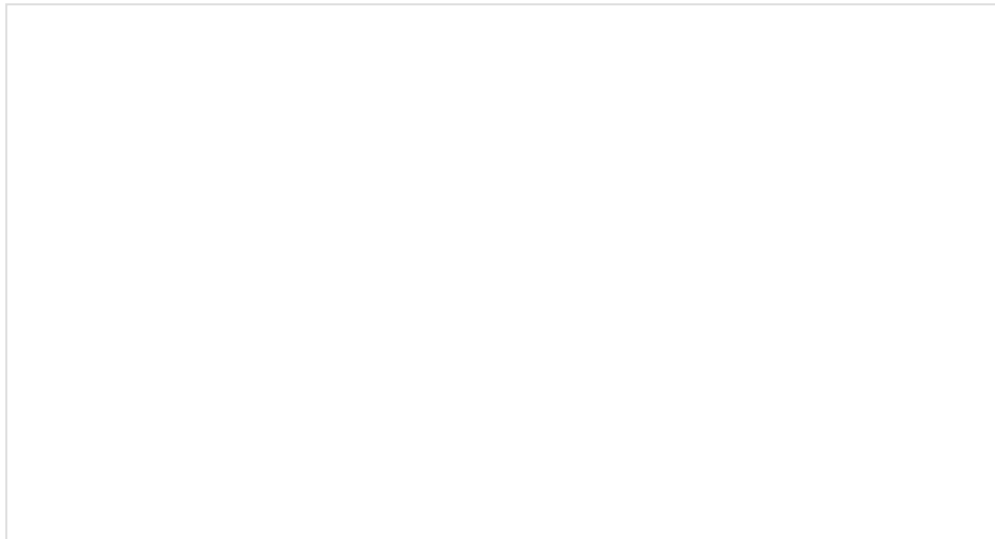
Guide for hooking up your Raspberry Pi 4 Model B basic, desktop, or hardware starter kit together.

If you're starting from scratch with a blank microSD card, you'll want to install Raspbian. If you've already got a working Raspbian system, skip ahead to the next section. Be patient — each of these steps can take a while depending on the speed of your microSD card.

1. **Download an Image** — Download your favorite Linux distribution. For beginners, we recommend getting NOOBS image.
2. **Flashing the Image** — Follow the instructions from the Raspberry Pi 4 Kit Hookup Guide to flash your microSD card. You can also follow the official Raspberry Pi installation instructions.

Configuring the Pi

The peripherals are not turned on by default. For those using Qwiic-enabled devices, you will want to enable I2C port. There are two methods to adjust the settings. This is outlined in our Raspberry Pi I2C tutorial.



Raspberry Pi SPI and I2C Tutorial

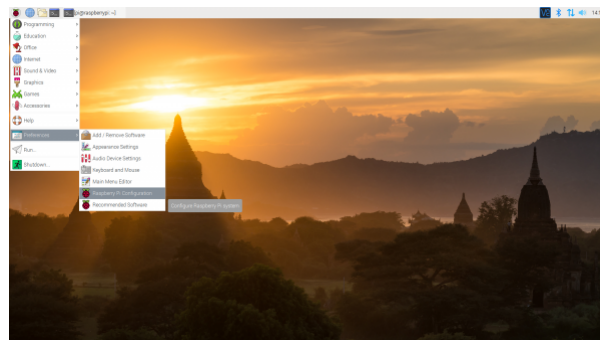
OCTOBER 29, 2015

Learn how to use serial I2C and SPI buses on your Raspberry Pi using the wiringPi I/O library for C/C++ and spidev/smbus for Python.

We've included the following instructions from the tutorial. To enable it, follow the steps below.

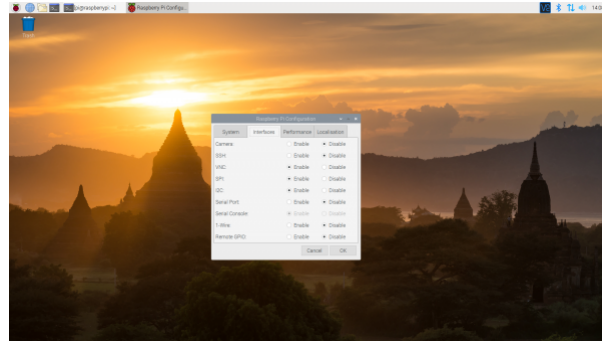
Raspberry Pi Configuration via Desktop GUI

You can use the Desktop GUI by heading to the **Pi Start Menu > Preferences > Raspberry Pi Configuration**.



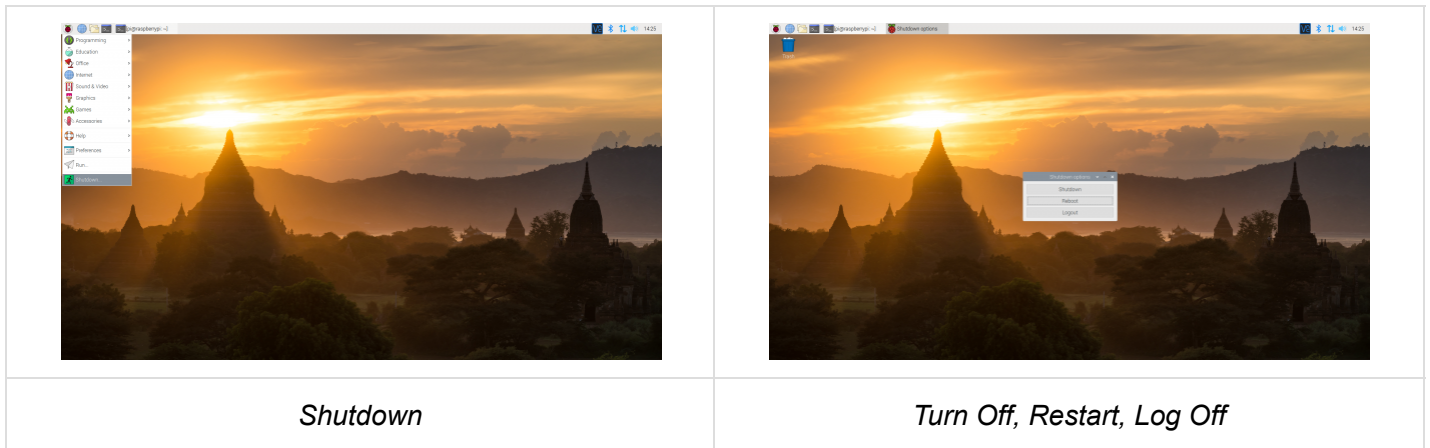
Click on image for a closer view.

A window will pop up with different tabs to adjust settings. What we are interested is the **Interfaces** tab. Click on the tab and select **Enable** for **I2C**. At this point, you can enable additional interfaces depending on your project needs. Click on the **OK** button to save.



Click on image for a closer view.

We recommend restarting your Pi to ensure that the changes take effect. Click on the **Pi Start Menu > Preferences > Shutdown**. Since we just need to restart, click on the **Restart** button.



Shutdown

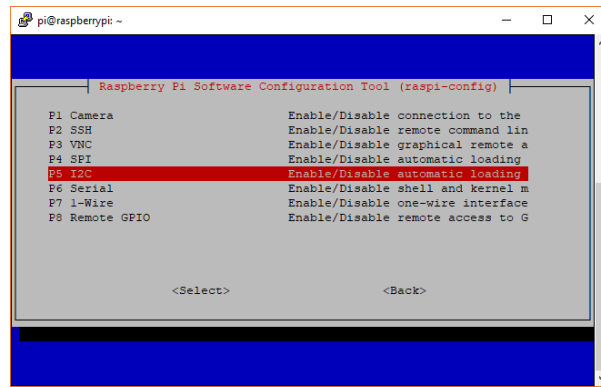
Turn Off, Restart, Log Off

Click on images for a closer view.

raspi-config Tool via Terminal

Again, we can use `raspi-config` to enable it.

1. Run `sudo raspi-config`.
2. Use the down arrow to select 5 Interfacing Options
3. Arrow down to P5 I2C .
4. Select `yes` when it asks you to enable I2C
5. Also select `yes` if it asks about automatically loading the kernel module.
6. Use the right arrow to select the `<Finish>` button.
7. Select `yes` when it asks to reboot.



Raspi-config for I2C

The system will reboot. When it comes back up, log in and enter the following command

```
ls /dev/*i2c*
```

The Pi should respond with

```
/dev/i2c-1
```

Which represents the user-mode I2C interface.

Scanning for I2C Devices

If you are using the Raspberry Pi to quickly connect to I²C devices, the best place to start would be to scan for an I²C device on the bus.

Utilities

There is a set of command-line utility programs that can help get an I²C interface working. You can get them with the apt package manager. Enter the following command.

```
sudo apt-get install -y i2c-tools
```

In particular, the `i2cdetect` program will probe all the addresses on a bus, and report whether any devices are present. Enter the following command in the command line. The `-y` flag will disable interactive mode so that you do not have to wait for confirmation. The `1` indicates that we are scanning for I²C devices on I²C bus 1 (e.g. `i2c-1`).

```
i2cdetect -y 1
```

You will get an output from your Raspberry Pi similar to the output below.

```
pi@raspberrypi:~/ $ i2cdetect -y 1
    0  1  2  3  4  5  6  7  8  9  a  b  c  d  e  f
00:  -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
10:  -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
20:  -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
30:  -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
40:  -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
50:  -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
60: 60 -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
70:  -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
```

This map indicates that there is a peripheral at address **0x60**. Your address may vary depending on what is connected to the I²C bus. For advanced users, you can try to read and write its registers using the `i2cget` , `i2cset` and `i2cdump` commands.

Qwiic Py Drivers

Now that you have I²C set up on your Pi, you can start programming your Qwiic devices on your Pi or if you'd like to start with some examples, we have a host of Python drivers for Qwiic breakouts available in the GitHub repository linked below. You can read more about Python for the SparkFun Qwiic system in this blog post.

[**SPARKFUN QWIIC PY GITHUB REPO**](#)

GPIO Pins

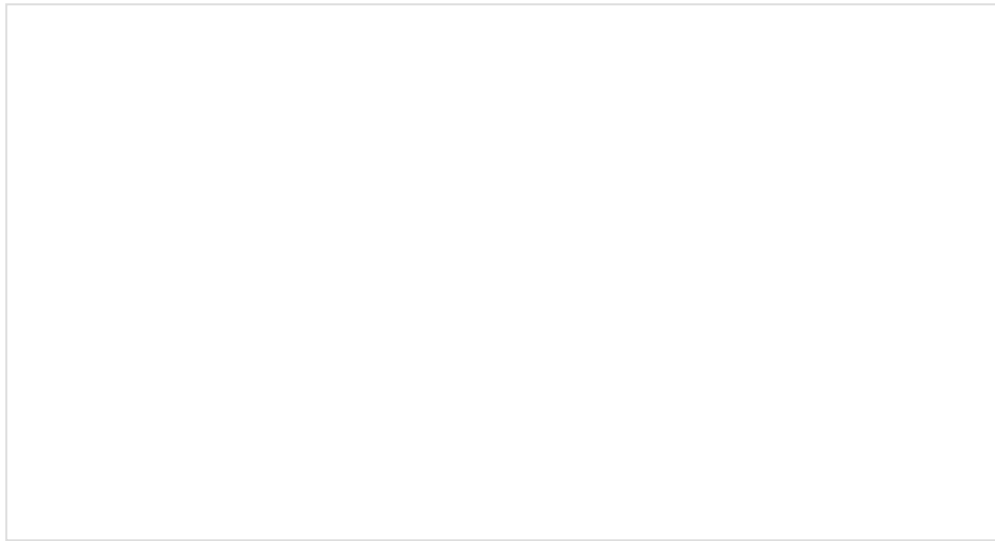
The Raspberry Pi 400 uses the standard 2x20 GPIO pins. With the help of the Qwiic pHAT extension, the Pi 400's horizontal GPIO pins are rerouted to a vertical position. There are several programming languages available to use on the Raspberry Pi. We recommend Python to control the pins. Check the following tutorials below to get started.



Python Programming Tutorial: Getting Started with the Raspberry Pi

JUNE 27, 2018

This guide will show you how to write programs on your Raspberry Pi using Python to control hardware.



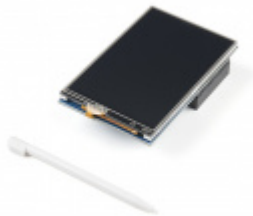
Raspberry gPlo

OCTOBER 29, 2015

How to use either Python or C++ to drive the I/O lines on a Raspberry Pi.

Stack a Hat

With the Pi 400 2x20 pins rerouted to a vertical position, you can stack on a HAT. Check out a few of the HATs below from the SparkFun catalog.



LCD Touchscreen HAT for Raspberry Pi - TFT
3.5in. (480x320)

● LCD-17520



SparkFun GPS-RTK Dead Reckoning pHAT for
Raspberry Pi

● GPS-16475



SparkFun Pulsed Radar Breakout - A111

● SEN-15577



SparkFun Qwiic pHAT Extension for Raspberry
Pi 400

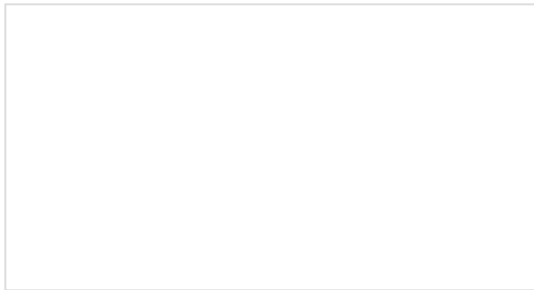
● DEV-17512

Resources and Going Further

For more information, check out the resources below:

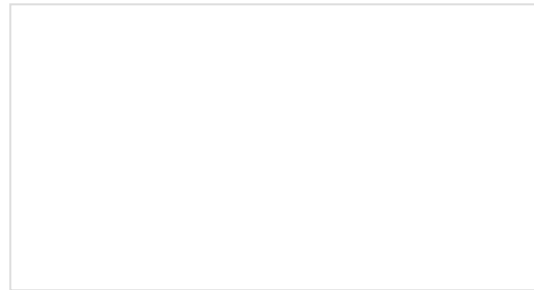
- Schematic (PDF)
- Eagle Files (ZIP)
- Board Dimensions (PNG)
- GitHub Repo

Now that you have your Qwiic pHAT extension ready to go, it's time incorporate it into a project! Check out any tutorials that are tagged with Raspberry Pi for ideas.



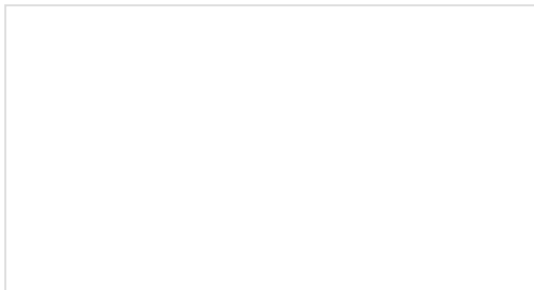
Serial Terminal Basics

This tutorial will show you how to communicate with your serial devices using a variety of terminal emulator applications.



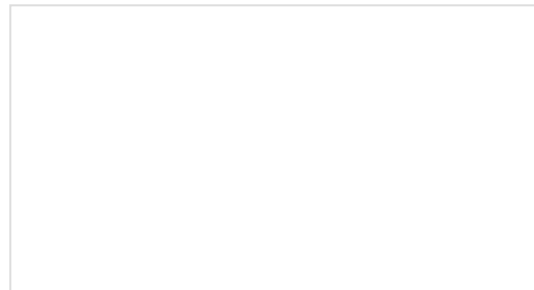
Raspberry gPIo

How to use either Python or C++ to drive the I/O lines on a Raspberry Pi.



SparkFun Top pHAT Hookup Guide

The pHAT to sit above your other HATs. Does that make it the "king" of the pHATs? This guide will help you get started using the Top pHAT with the Raspberry Pi.



SparkFun GPS-RTK Dead Reckoning ZED-F9R Hookup Guide

The u-blox ZED-F9R is a powerful GPS-RTK unit that uses a fusion of IMU, wheel ticks, a vehicle dynamics model, correction data, and GNSS measurements to provide highly accurate and continuous position for navigation in the difficult conditions. We will quickly get you set up using the Qwiic ecosystem through Arduino and Python so that you can start reading the output!